Thread Spacer

DESCRIPTION

[Para 1] BACKGROUND OF THE INVENTION

[Para 2] Cross reference to related Applications

[Para 3] This application claims priority from U.S. Provisional Patent Application No. 60/481,395 filed September 18, 2003.

[Para 4] 1. Field of the Invention.

[Para 5] This invention relates to the industry for the exploration and recovery of minerals from beneath the earth. In particular the invention is a thread spacer that is placed intermediate the threaded couplings used to join the drilling pipes used in this industry.

[Para 6] 2. Description of the Related Art.

[Para 7] In the pipe industry, particularly pipes related to the exploration and recovery of minerals from beneath the earth, there has been a need to find a way to lubricate and seal the threads of threaded couplings on the pipes. Viscous thread compounds, such as pipe dope and variants thereof, are often used to provide this sealing and lubrication. However, not only are these lubricants difficult to use and to clean up, many contain materials that have been identified as environmental hazards. In addition, these compounds often

interfere with the making up of the threaded connections, as the lubricant must be given time to squeeze out from the between the threads as they are made up.

[Para 8] One solution has been to provide intermediate, relatively ductile, solid threaded couplings made of, or plated with, materials with lubricating properties. Typically these materials are comprised of relatively ductile metals such as alloys of copper, lead, silver, etc. It is also possible to make these couplings from the same material as the couplings on the pipes - except that they are made to be more ductile to facilitate 'cold flow' when made up such that they yield during assembly to fill the gaps in the pipe threads, thereby providing a sealing action. Numerous patents have been granted relating to this type of intermediate threaded couplings.

[Para 9] US Patent No. 1,543,963 incorporated by reference herein for all it contains describes a ductile metallic packing of lead foil. US Patent No. 2,145,168 incorporated by reference herein for all it contains, describes threaded cooperating faces which are sealed by a coating of relatively softer metal to maintain the seal. Furthermore, this coating may be melted to produce a permanent joint. US Patent No. 2,296,198 incorporated by reference herein for all it contains discloses an intermediate spiral spacer to facilitate making a threadless pipe connection. US Patent No. 2,407,522 incorporated by reference herein for all it contains discloses a thin thread spacer in the form of a hollow, truncated cone with undulating threads to be disposed intermediate two pipe threaded connections. The spacer forms a gasket between the connections and may or may not have an integral flange. It is preferably formed of copper or a copper based alloy.

[Para 10] A thin threaded bushing with similar characteristics to the '522 patent is disclosed in US Patent No. 2,825,584 incorporated by reference herein for all it contains. In addition, although used for dry wall fasteners,

another very similar threaded structure is disclosed in US Patent No. 4,878,794 also incorporated by reference herein for all it contains.

[Para 11] US Patent No. 6,371,224 incorporated by reference herein for all it contains describes a method and apparatus for forming a thread spacer with an integral flange. The spacer is useful for pipe connections used in the drilling industry, and is preferably made of beryllium copper. However, it is known that the integral flange disclosed in this patent often breaks from the cone shaped thread spacer body. Once this fracture occurs, the thread spacer may need to be replaced, depending upon the exact location and magnitude of the crack. Granted Italian Patent No. 01283507 describes a similar beryllium copper thread spacer with an integral flange. It is believed that this design suffers the same cracking problem, as previously described. In both designs, once the flange breaks away from the thread spacer, it is possible that it will fall away from the drill pipe upon disassembly. This becomes a serious problem if the flange and/or the thread spacer falls into the well bore as the drill pipes are detached.

[Para 12] Patent publication No. SU 1834780 describes a method of making a thread spacer for use in pipe connections for the drilling industry. The thread spacer is made by mechanical deformation, and a variety of means for forming threads by mechanical deformation are disclosed.

[Para 13] One problem with these thread spacers is that they do not consistently engage at the same position on the pipe threads. The position of the thread spacer may vary by several thread widths from connection to connection. This problem can be made worse when stabbing the pipes together. If the pipes are not carefully aligned and screwed together, the thread spacer can easily be pushed out of position further into the box connection during the stabbing operation. This may cause severe operational problems due to the taper of the threads. If the thread spacer is not

positioned properly along the length of the pipe threads, it may fracture or buckle upon assembly. Once this happens the ability of the thread spacer to carry the loads applied during make-up and operation may be severely compromised. This may lead to premature failure of the pipe coupling during operation.

[Para 14] The drilling Industry's recommendation is to mix the order of the pipes upon reassembly to even the wear among the pipes. This presents an additional problem with these types of thread spacers, as there is a tendency for the spacer to randomly remain with either the box or the pin connections of the pipes upon disassembly. This causes problems when handling the pipe in operation, because when the pipes are re-assembled, care must be taken to assure that exactly one thread spacer is positioned between each connection of the pipes. This assurance is quite difficult to achieve in current drill pipe handling practice. Therefore, the tendency of the operator is to reassemble the pipes in exactly the same order as they were disassembled, instead of mixing the order of reassembly, as recommended.

[Para 15] BRIEF SUMMARY OF THE INVENTION

[Para 16] The present invention is a thread spacer for threaded connections used in the drilling industry. Disclosed is a new thread spacer with an attached flange that is designed to easily break away from a thin thread spacer body. Also disclosed is a new thread spacer with two flanges, one on each end, for use in double shouldered threaded connections. In addition, a flange for a thread spacer is disclosed which has a thickness that takes into consideration not only the displacement in the pipes caused by the insertion of the thread spacer, but also compensated to provide the same stress at the shoulders as the joined pipes achieve without a thread spacer. The flange thickness may be incrementally increased if the flange has a Young's modulus

considerably less than that of the connection, and decreased if it has a considerably higher Young's modulus.

[Para 17] Also disclosed is a new thread spacer with a separate flange and a thread spacer flange retention apparatus, which retain the flange on one of the pipe connections when the pipes are separated. In addition, apparatus to cause the thread spacer to remain attached to one of the box and pin connections of a pipe are disclosed.

[Para 18] Further disclosed is a thread spacer without a flange that is disposed between the threaded connections of mating drill pipes. The threads of the connections are designed to accommodate the thickness of the thread spacer so that flanges are not required. It is also possible to adapt the thread form of these connections to allow a more evenly distributed compressive loading on the thread spacer - minimizing potential failures due to over stressing the thread spacer material.

[Para 19] BRIEF DESCRIPTION OF THE DRAWINGS

[Para 20] Figure 1 is a partial section view of a typical drilling rig using drill pipes with thread spacers of the present invention.

[Para 21] Figure 2A is a single flange thread spacer of the present invention, showing precut tabs to facilitate flange breakout.

[Para 22] Figure 2B is a double flange thread spacer of the present invention, showing two sets of precut tabs to facilitate flange breakout.

[Para 23] Figure 3 is a double shoulder pipe connection utilizing the double flange thread spacer of figure 2B.

[Para 24] Figure 4A is a single shoulder pipe connection utilizing the single flange thread spacer of figure 2A.

[Para 25] Figure 4B is an enlargement of a portion of figure 4A, showing the material left after the flange has broken from the thread spacer.

[Para 26] Figure 5 is a partial section view of a pipe connection with a flange retainer of the present invention, wherein retention is accomplished by utilizing a portion of the thread spacer broken away during assembly.

[Para 27] Figure 6 is a perspective view of a thread spacer with no flanges with precut tabs intended to engage the inside of the pipe connection for retention within the pipe.

[Para 28] Figure 7 is a section view of a double-shouldered pipe connection adapted for use with the flangeless thread spacer similar to that shown in figure 6.

[Para 29] Figure 8A is a partial section view of a threaded box connection adapted with a groove for a thread spacer flange of the present invention.

[Para 30] Figures 8B-8G show various groove configurations of the threaded box connection of Fig. 8A, to retain the flange.

[Para 31] Figure 9A is a partial section view of a threaded pin connection adapted with a groove for a thread spacer flange of the present invention.

[Para 32] Figures 9B-9G show various groove configurations of the threaded pin connection of Fig. 9A, to retain the flange.

[Para 33] Figures 10A-10 J are partial section views of threaded connections illustrating various combinations of the thread spacer and the flange on the box and pin connections.

[Para 34] Figure 11 is a partial section view of a box connection of one embodiment of the invention showing a thread modified such that the thread spacer is retained within the box.

[Para 35] Figure 12 is a partial section view of a pin connection of one embodiment of the invention showing a thread modified such that the thread spacer is retained upon the pin.

[Para 36] DETAILED DESCRIPTION OF THE INVENTION AND THE PREFERRED EMBODIMENT

[Para 37] When drilling boreholes into earthen formations, it is common practice to use a bottom hole assembly as shown in Figure 1. The bottom hole assembly, generally indicated as 10, is typically connected to the end of the tubular drill string 12 which is typically rotatably driven by a drilling rig 8 from the surface. In addition to providing motive force for rotating the drill string 12, the drilling rig 8 also supplies a drilling fluid under pressure through the tubular drill string 12 to the bottom hole assembly 10. The drilling fluid is typically laden with abrasive material, as it is repeatedly re-circulated through the borehole. Other components of the bottom hole assembly 10 include a drill bit 11, and various other down hole components.

[Para 38] Typically the drill string 12 is comprised of a plurality of drill pipes 14 joined by a plurality of threaded connections 16, 18, 20, 22, as shown in the Figures, which are typically of tapered configuration. These tapered threaded connections 16, 18, 20, 22 typically have a set of male pipe threads 30, 32, 34, 36, 130 forming what is known as a pin section 31, 33, 35, 37, 131 and a set of female threads 38, 40, 42, 44, 138 forming what is known as a box section 39, 41, 43, 45, 139. Typically each drill pipe 14 has a longitudinal axis 98 and one tapered box section and one tapered pin section, one on each end, although it is known to sometimes have pipe sections with box connections on both ends or pin connections on both ends. The box sections 39, 41, 43, 45, 139 are adapted to mate with the pin sections 31, 33, 35, 37, 131 with screw threads to join the drill pipes 14 in a known manner.

[Para 39] The thread spacer 50, 52, 54, 56, 58, 60, 62 of the present invention is disposed between the box sections 39, 41, 43, 45, 139 and the pin sections 31, 33, 35, 37, 131 to provide relief of the friction from sliding, the high stress from tightening and the pressure when the drill pipes 14 are screwed together. The friction, stress and pressure, in combination with the high temperatures and other factors encountered during drilling, had previously caused the threaded connection to be prone to seizing or galling in the threads.

[Para 40] The thread spacer 50 shown in figure 2A is a thin, hollow, truncated conical member of generally uniform thickness with a longitudinal axis 51, 53, 61 and having undulating threads 70 formed on the exterior portion 72 and adapted to be cooperatively engaged with the set of female threads 38, 40, 42, 44, 138 of a box section 39, 41, 43, 45, 139. In a similar manner, undulating threads 74 formed on the interior portion 76 of the thread spacer 50, 52, 54, 56, 58, 60, 62 are adapted to cooperatively engage with the set of male pipe threads 30, 32, 34, 36, 130. Precut tabs 78 may be formed at one or more places along at either end of the thread portion of the spacer 50. The precut tabs 78 have multiple functions, as will be explained.

[Para 41] The thread spacer 50, 52, 54, 56, 58, 60, 62 may be formed of any suitable material, including non-metallic composites such as carbon fiber, or may be relatively ductile metallic materials such as copper, copper alloys, especially beryllium copper. It is also possible to use layered metallic materials such as a thin plate of steel clad with copper, silver, other relatively ductile metals, or of alloys thereof. It is also possible to provide special treatments to provide high yield strengths for ductile materials, such as found in copper based spinodal alloys. Generally, it is desirable to provide a material for these thread spacers which has a ductility of greater than about 5% and a yield strength of greater than about 120,000 PSI. Purpose built threaded connections may have thread forms that allow very ductile materials for thread spacers 50, 52, 54, 56, 58, 60, 62. For these purpose built connections, yield strengths of the thread spacer material may be less than 50,000 PSI. One such purpose built design is illustrated in figure 7.

[Para 42] It should be noted that the Young's Modulus, or the modulus of elasticity of suitable thread spacer materials might be different from that of the drill pipes 14, as will be discussed.

[Para 43] The thread spacer 50, 52, 54, 56, 58, 60, 62 may have associated with it an OD flange 80, 82 and/or an ID flange 84. The flange 80, 82, 84, 180 may optionally be attached to the thread spacer 50, 52, 54, 56, 58, 60, 62 by attachment to the precut tabs 78. The attachment of the thread spacer to the precut tabs 78 may be made by welding, adhesives, mechanical attachment, tying with wire or other suitable attachments. In use, the flange 80, 82, 84, 180 tends to separate from the thread spacer 50, 52, 54, 56, 58, 60, 62 so the attachment must be configured in a manner that allows controlled separation of the flange from the thread spacer without significant damage to either. When the flange 80, 82, 84, 180 is attached to the precut tabs 78, the shape, size, and orientation configuration of the precut tabs 78

allows controlled breakage of the tab 78 from the thread spacer in a manner that does not interfere with the threading of the spacer of the pipe 14.

[Para 44] It is also possible to attach the flange 80, 82, 84, 180 directly to other portions of the thread spacer 50, 52, 54, 56, 58, 60, 62 and not to the precut tabs 78, provided the attachment and subsequent breakout is made in a manner that will not cause significant damage to either. For example, the flange may be attached directly to the thread spacer by welding, adhesives, mechanical attachment, tying with wire or other suitable attachments. In this embodiment, however, it is important to minimize the amount of material that breaks off of the thread spacer 50, 52, 54, 56, 58, 60, 62 when the flange 80, 82, 84, 180 separates from it upon assembly with one of the pipes 14.

[Para 45] As can be seen in Figures 4A and 4B the remnants 88, 89 remaining attached to the flange 80 and the thread spacer 50, 52, 54, 56, 58, 60, 62 in this manner will not interfere with the operation of the thread spacer or the flange. In fact the remnants 89 remaining attached to the thread spacer 50, 52, 54, 56, 58, 60, 62 may be used as a positive stop to properly locate the thread spacer along the threads. The precut tabs 78 may also be used to locate the thread spacer properly on the threads of the pipes when it is made up. Additionally, the same types of attachments used to retain the flange 80, 82, 84, 180 may be adapted to provide a positive stop to firmly and positively locate the thread spacer 50, 52, 54, 56, 58, 60, 62 in the proper position on the threads 30, 32, 34, 36, 38, 40, 42, 44, 130, 138. Additionally, the fasteners for firmly attaching the thread spacer to the pipe (as described below) may also be suitable locating devices.

[Para 46] In the course of the drilling operation, it is necessary to make up and breakout the drill pipes repeatedly. In order to prevent the loss of the flange 80, 82, 84, 180 and/or the thread spacer 50, 52, 54, 56, 58, 60, 62 during breakout, it is desirable to retain them upon the tapered threaded

connections 16, 18, 20, 22 of the drill pipe 14. In some embodiments, the precut tabs 78 that break away from the thread spacer may remain firmly attached to the flange 80, 82, 84, 180. These remnants of the precut tabs 78 may be configured to help retain the flange 80, 82 on the pin section 31, 33, 35, 37, 131 by engaging a groove 86 in the pin section, as shown in figure 5.

[Para 47] Because the thread spacer 50, 52, 54, 56, 58, 60, 62 can also come loose during operation, an adhesive material may be applied to either the thread spacer or the pipe threads to fix the thread spacer to one of the pin sections 38, 40, 42, 44, 138 or the box sections 39, 41, 43, 45, 139. Alternately, a coating with a high friction factor, such as a layer of thin soft rubber, may be applied to the interior portion 76 or the outer portion 72 of the thread spacer 50, 52, 54, 56, 58, 60, 62 such that the spacer remains fixed upon the pipe 14.

[Para 48] Since a phosphate coating is often applied to the threads 30, 32, 34, 36, 38, 40, 42, 44, 130, 138, for wear resistance, the coating may be applied selectively to one of either the male or female threads to provide a difference in friction of the box 39, 41, 43, 45, 139 and pin 38, 40, 42, 44, 138 sections, causing the thread spacer 50, 52, 54, 56, 58, 60, 62 to remain with, and fixed upon one of the box and pin, whichever has the higher friction. Alternatively – as shown in Figures 11 and 12 one of the sets of threads may be machined or subsequently treated in a manner that provides a suitable difference in friction. For example one of the sets of threads 30, 32, 34, 36, 38, 40, 42, 44, 130, 138 may be machined with small, radial grooves to increase the friction. Also, sandblasting or application of a grit on one set of the threads 30, 32, 34, 36, 38, 40, 42, 44, 130, 138 may also be used to increase the friction.

[Para 49] In a preferred embodiment, the set of the threads 30, 32, 34, 36, 38, 40, 42, 44, 130, 138 are cold worked in some manner and then shot and/or grit blasted to provide this increase in friction. All these provide a

suitable difference in friction to fix the thread spacer 50, 52, 54, 56, 58, 60, 62 on to one set of the threads 30, 32, 34, 36, 38, 40, 42, 44, 130, 138.

[Para 50] In another embodiment, the precut tabs 78 of the thread spacer 50, 52, 54, 56, 58, 60, 62 may be deformed in a manner such that they engage a notch (not shown) in the pipe to prevent back off once tightened - or the precut tabs 78 may be oriented in a manner which increases the friction between the thread spacer and the pipe 14 to maintain retention. Additional ways of securing the thread spacer onto the pipe are, modifying the friction characteristics of the pipe threads by providing machines-in interference or by applying various insets and/or lock members. Also, various fasteners such as screws, latches, pins, dimples, etc. which engage mating recesses in the other member may be applied to the thread spacer and/or the pipe to prevent the thread spacer 50, 52, 54, 56, 58, 60, 62 from coming loose. These same fasteners may also be used to positively locate the thread spacer in the proper position with respect to the threads, as previously described.

[Para 51] In other embodiments, as shown in Figures 8A-8G and Figures 9A-9G the flange 180 mounted separately from the thread spacer 50, 52, 54, 56, 58, 60, 62. In these embodiments, the flange 180 is designed to lock within one of the pin section 131 and box section 139. In the configuration for the box section 139 shown in Figure 8A, the flange 180 is shown mounted in a groove 100 in the shoulder 140 of the box section 139. As shown in Figure 8B the flange 180 may be retained within an overhanging groove 102, with the 'under hanging' groove 104 of Figure 8C, of the straight ended groove 106 of Figure 8D. Other groove shapes, such as a curved sided groove 108, protruding dimpled groove 110 and recessed dimple groove 112 of Figures 8E-8G. In each of the embodiments of Figures 8A-8G, the flange 180 may be shaped to fit the shape of the groove and pressed fit, shrunk fit (by cooling of the flange or heating of the connection), of interference fitted (pressed) into place in the respective groove 100, 102, 104, 106, 108, 110, 112.

[Para 52] In the configuration of the pin section 131 as shown in Figures 9A-9G the flange 180 is mounted in a "T" shaped groove 101 in the shoulder 132 of the pin section 131. As shown, the flange 180 may be held in place by a protruding dimple 116 formed in the pin section 131, an undercut 118, a secondary groove 114, an overhanging groove 120 as shown in Figure 9B, an 'under hanging' groove 122 as shown in Figure 9C, or any combinations thereof.

[Para 53] As shown in Figures 10A-10J, there are four basic arrangements for the thread spacer 50, 52, 54, 56, 58, 60, 62 and the flange 80, 82, 84, 180 on a drill pipe 14. Figures 10A and 10B show the flange 80, 82, 84, 180 and the thread spacer 50, 52, 54, 56, 58, 60, 62 both mounted in the box section box section 39, 41, 43, 45, 139 of the drill pipe 14. Figures 10C and 10D show the flange 80, 82, 84, 180 and the thread spacer 50, 52, 54, 56, 58, 60, 62 both mounted in the pin section box section 31, 33, 35, 37, 131 of the drill pipe 14. Figures 10E through 10G show the flange 80, 82, 84, 180 mounted in the box section box section 39, 41, 43, 45, 139 of the drill pipe 14 and the thread spacer 50, 52, 54, 56, 58, 60, 62 mounted in the pin section box section 31, 33, 35, 37, 131 of the drill pipe 14. Finally, Figures 10H through 10J show the thread spacer 50, 52, 54, 56, 58, 60, 62 mounted in the box section box section 39, 41, 43, 45, 139 of the drill pipe 14 and the flange 80, 82, 84, 180 mounted in the pin section box section 31, 33, 35, 37, 131 of the drill pipe 14.

[Para 54] As shown in the double shouldered connection in Fig.3, the flanges 80, 82, 84, 180 have thickness T1 and T2 that may vary depending upon the thickness and form of the threads 70 of the thread spacer 50, 52, 54, 56, 58, 60, 62. Normally, this thickness can be calculated knowing the taper angle and the thread characteristics along with the thickness of cone of the thread spacer 50, 52, 54, 56, 58, 60, 62. In some circumstances, it may be desirable to adjust the thickness T1 and T2 to compensate for differences in the Young's Modulus between the thread spacer material and the pipe 14 material. This

may be required to insure that the compressive stress at the shoulders of the pipe is maintained upon makeup at the level necessary to minimize fatigue of the threads of the pipe 14. If the material of the thread spacer has a Young's Modulus considerably less than or considerably greater than the Young's Modulus of the pipe 14 material, the thickness T1 and T2 may have to incrementally increased or decreased accordingly.

[Para 55] Whereas the present invention has been described in particular relation to the drawings attached hereto, it should be understood that other and further modifications apart from those shown or suggested herein, may be made within the scope and spirit of the present invention. For example, although the examples herein are drawn to the threaded connections on drill pipes, other types of pipes such as casing, production tubing, offshore drill risers, production risers and many other types of piping may also benefit from the new thread spacer disclosed herein. Also, the thread spacers of the present invention may be used in conjunction with pipe couplings, where a separate pipe-coupling member is used to join two pipes together.